

Appl. No. 10/810,309
Amdt. Dated July 27, 2006
Reply to Office Action of April 28, 2006

Attorney Docket No.81716.0122
Customer No.: 26021

REMARKS/ARGUMENTS:

Claims 2, 4, 6, 8, 10-13, and 19 are pending in the application. Reexamination and reconsideration of the application, in view of the following remarks, are respectfully requested.

The invention relates to a semiconductor apparatus and specifically relates to a semiconductor apparatus, a method for growing a nitride semiconductor and a method for producing a semiconductor apparatus which are suitable for a light emitting device and a light receiving device such as a light emitting diode (LED), a laser diode (LD), a solar cell and a photosensor, and an electronic device such as a transistor and a power device. (Applicant's specification, at p. 1, lines 7-14).

CLAIM REJECTIONS UNDER 35 U.S.C. § 103:

Claims 2, 4, 6, 8, and 19 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,583,468 to Hori et al. (or EP 1213767) in view of U.S. Patent No. 6,586,819 to Matsuoka. The Applicant respectfully traverses this rejection. Claim 2 is as follows:

A semiconductor apparatus comprising:

a substrate made of a diboride single crystal expressed by a chemical formula XB_2 , in which X includes at least one of Ti, Zr, Nb and Hf,

wherein an angle θ_1 formed by a normal line of a principal surface of the substrate and a normal line of a (0001) plane of the substrate is $0^\circ < \theta_1 \leq 0.55^\circ$;

a semiconductor buffer layer formed on the principal surface of the substrate and made of $(AlN)_x(GaN)_{1-x}$ ($0 < x \leq 1$); and

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a nitride semiconductor layer formed on the semiconductor buffer layer, including at least one kind or plural kinds selected from among 13 group elements and As.

Hori, as acknowledged by the Office, fails to teach or suggest a semiconductor apparatus wherein an angle θ_1 , formed by a normal line of a principal surface of the substrate and a normal line of a (0001) plan of the substrate is $0^\circ < \theta_1 \leq 0.55^\circ$. The Office relies on Matsuoka for supplying this teaching.

Matsuoka teaches that in order to prevent twin crystals from growing in a GaN layer formed on a sapphire substrate, a surface which is rotated from M plane ({01-10} plane) of the substrate by about 15° around the c-axis is used as a growth surface for GaN. Matsuoka further teaches that a stripe pattern is formed in the GaN layer under the above-mentioned growth condition (Matsuoka, column 8, lines 15-17), and that a surface of the substrate which is further tilted by 0.1° to 2° with respect to the c-axis is used as a growth plane for GaN in order to eliminate the stripe pattern (Matsuoka, column 8, lines 25-38).

Whereas the substrate of the present invention is a diboride single crystal, that of Matsuoka is made of sapphire. Therefore, claim 2 of the present invention is different from Matsuoka in this respect.

Further, the purpose of setting the angle θ_1 formed by the normal line of the principal surface of the substrate and the normal line of the (0001) plane of the substrate to be $0^\circ < \theta_1 \leq 0.55^\circ$ in the present invention is to specify a permissible angle range of θ_1 for good lattice alignment sufficient to secure a good performance of the apparatus, because it is very difficult to set $\theta_1 = 0^\circ$ precisely though $\theta_1 = 0^\circ$ is desirable for optimal lattice alignment.

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In contrast, the purpose of setting the growth plane tilted by 0.1° to 2° with respect to the c-axis in Matsuoka is to prevent the stripe pattern from being formed and thus to make the surface of the GaN layer smooth.

Therefore, Matsuoka, which not only uses a substrate made of different material but also tilts the growth plane intentionally, fails to teach or suggest the present invention which intentionally suppresses the tilt of the growth plane.

Applicant respectfully submits that even though making the growth surface tilted by 0.1° to 2° with respect to the c-axis may be effective in making the surface of a GaN layer formed on a sapphire substrate smooth; there is no reason to believe that this is also effective in achieving a good lattice alignment between a diboride single crystal substrate and an $(\text{AlN})_x(\text{GaN})_{1-x}$ layer formed thereon. Thus, one having ordinary skill in the art would not have reached the present invention based on the teachings of Hori and Matsuoka.

Further, by setting $0^\circ < \theta_1 \leq 0.55^\circ$, thus making θ_1 slightly off from 0° , an atomic step layer (a layer having a step whose height corresponds to one atom) is formed on the principal axis of the substrate. Since the portion where the atomic step layer is formed serves as a starting point for the crystal growth of the nitride semiconductor layer, the crystal growth of the semiconductor layer is facilitated and the growth rate is increased.

In the case of $\theta_1=0^\circ$, since no definite starting point of crystal growth is present, crystal defects tend to be formed in the nitride semiconductor layer, when crystal growth with high growth rate is attempted.

In light of the foregoing, Applicant respectfully submits that the cited references could not have rendered obvious claim 2, because the cited references fail to teach or suggest each and every claim limitation. Claims 4, 6, 8, and 19 depend

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from claim 2 and cannot be rendered obvious for at least the same reasons as claim 2. Withdrawal of these rejections is thus respectfully requested.

Claims 10-13 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Hori and Matsuoka and further in view of U.S. Patent No. 6,586,819 to Koike et al. (or EP 1263031). The Applicant respectfully traverses this rejection.

Claims 10-13 depend from claim 2 and therefore, cannot be rendered obvious over Hori and Matsuoka for the reasons discussed above. Koike cannot remedy the defect of Hori and Matsuoka and is not relied upon by the Office for such. Instead, the Office cites Koike for teaching a buffer layer having the composition of $\text{Al}_x\text{Ga}_{1-x}\text{N}$ ($0 \leq x \leq 1$).

In light of the foregoing, Applicant respectfully submits that the cited references could not have rendered obvious claims 10-13, because the cited references fail to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Reexamination and reconsideration of the application, in view of the foregoing remarks, are requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (213) 337-6700 to discuss the steps necessary for placing the application in condition for allowance.

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If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,

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